

News Briefs

General Developments

HPEAK: A COOL TOOL FOR ANALYZING HEAT PUMPS

Heat pumps are getting smarter. Some of the newest models not only heat and cool your home but provide hot water as well. But how do these advanced systems affect energy consumption and are they cost effective? To get some answers, NIST researchers developed a computer program to evaluate the performance and economics of conventional and advanced heat pump and water heating systems. Called HPEAK (Heat Pump/Economic Analysis of Kilowatt-hours), the program can simulate the daily, hour-by-hour operation of a heat pump and can predict the monthly and annual energy consumption as well as peak demand times. It also can be used to analyze the cost effectiveness of operating a particular heat pump system and can compare the energy consumption and costs of conventional and advanced heat pump systems. Designed to run on a personal computer, HPEAK can be used by electric utilities, heat pump manufacturers, and building researchers. The software and related documentation is available from the Electric Power Research Institute in Palo Alto, CA, 214/655-8883.

LESS EXPENSIVE VOLTAGE STANDARD DEVELOPED

A precise voltage is generated when microwave radiation is applied to a Josephson junction (two layers of superconducting material separated by a thin-film insulator). NIST researchers pioneered the development of voltage standards based on large arrays of superconducting Josephson junctions. Since 1984 more than 20 national, military,

and industrial standards laboratories have implemented Josephson array voltage standards. Until recently, however, the designs required a high microwave operating frequency (70-100 GHz) to achieve stable operation. This increases the cost of the standards, slowing their wider use in secondary calibration laboratories. Now, NIST scientists working with private industry have developed a successful design at an operating frequency of 24 GHz, a frequency at which the availability of equipment is significantly greater. As a result the possibility now exists of reducing the cost of the system significantly. Paper No. 43-90, which describes this development, is available from Jo Emery, Division 104, NIST, Boulder, CO 80303, 303/497-3237.

NOVEL NIST DEVICE MEASURES A VARIETY OF PULSES

A new measurement device that could help curb future electrical power outages as well as aid in the understanding of pulse phenomena such as heartbeats and pulsating fluids has been developed at NIST. The device, which makes real-time measurements of statistical correlations among pulses, is an improvement over other instruments that provide only limited information about pulse properties. NIST researchers have tested the instrument, called the stochastic analyzer for pulsating phenomena (SAPP), extensively by measuring the kinds of pulses that can occur when insulating materials in electrical systems are subjected to stress. These "partial discharge" pulses can induce material degradation that leads to eventual failure of the insulation, causing electrical breakdown in the system. Gauging and understanding these pulses is important because faulty insulating materials could mean the loss of electricity in large geographic areas. The NIST device can be used to study the underlying physics of pulsating discharges and

provide an indication of insulation performance. While they have mainly applied the device to electrical systems, NIST researchers say the SAPP can be used to investigate all kinds of pulsating phenomena.

ELECTROMAGNETIC MEASUREMENT PUBLISHED

NIST has published bibliographic updates for January 1970 through August 1989 in the general area of electromagnetic measurements. A Bibliography of the NIST Electromagnetic Fields Division Publications (NISTIR 89-3920) lists publications in the following areas: antennas, dielectric measurements, electromagnetic interference, microwave metrology, noise, remote sensing, time domain, and waveform metrology. Order by PB #90-163635FAH for \$23 prepaid. Metrology for Electromagnetic Technology: A Bibliography of NIST Publications (NISTIR 89-3921) identifies reports in the fields of optical electronic metrology, cryoelectronic metrology, and superconductor and magnetic measurement. Order by PB #90-161670FAH for \$17 prepaid. Both publications include author indices and are available from the National Technical Information Service, Springfield, VA 22161.

NIST WINS HONORS IN RESEARCH COMPETITION

Five advances in instrumentation and measurement technology developed at NIST received R&D 100 Awards at ceremonies Sept. 26 in Chicago. NIST also shared two awards for work done in collaboration with other research organizations. R&D 100 Awards are presented annually by Research & Development magazine to highlight the 100 "significant new technical products" of the preceding year. NIST projects honored this year are: a system for retrieving information from computer databases containing large amounts of text; a new type of microscope that uses optical techniques to examine the surface microstructure of materials; a device that measures a variety of rapid pulses such as heartbeats; a method of growing single crystals of proteins and other substances; and a system for measuring radiation dosage. The following two awards were shared: high-efficiency silicon diodes developed for space, defense, and numerous other applications (with UKDT Sensors Inc.); and a cryogenic refrigerator that has no moving parts (with Los Alamos National Laboratory).

NIST TURNS THE HEAT ON HOSPITAL ENERGY COSTS

NIST researchers have developed a personal computer (PC) program to help hospital managers evaluate the effectiveness of various energy conservation measures. HEAT—the Hospital Energy Analysis Toolkit—is a fully documented, menu-driven program. The user enters specific information about the facility—its location (zip code) and local energy prices, for example—and a description based on 21 prototype energy zones. Energy conservation plans of up to 10 elements can be specified for each zone. HEAT calculates and reports expected annual energy savings and economic results by zone for each plan, taking into account all interactions among different elements of the plan. The program runs on a standard MS-DOS PC with a hard disk drive and is available for \$60 plus \$3 handling, prepaid, from the National Technical Information Service, Springfield, VA 22161. Request PB #90-504036ACU.

FOUR COMPANIES WIN 1990 BALDRIGE NATIONAL QUALITY AWARD

The four winners of the 1990 Malcolm Baldrige National Quality Award for excellence in quality management were announced recently. They are: the Cadillac Motor Car Division (Detroit, MI) and IBM Rochester (Rochester, MN) in the manufacturing category; Federal Express Corp. (Memphis, TN) in service; and Wallace Co. Inc. (Houston, TX) in small business. Commerce Secretary Robert A. Mosbacher announced the awards and praised the winners for making quality improvement a way of life. "Quality is their bottom line, and that kind of can-do attitude makes for world-class products and services," he said. The award, named for the late Commerce Secretary Malcolm Baldrige, was established by legislation in August 1987. It promotes national awareness about the importance of improving total quality management and recognizes quality achievements of U.S. companies. The award is managed by NIST with the active involvement of the private sector.

QEI SPOTLIGHTS QUALITY AWARD WINNERS

"Quest for Excellence III," an executive conference featuring the 1990 winners of the Malcolm Baldrige National Quality Award, will convene Feb. 13-14, 1991 at the Sheraton Washington Hotel

in Washington, DC. Senior executives from the winning companies will discuss in detail their winning strategies and the results they have achieved through their quality improvement initiatives. This third annual conference is co-sponsored by NIST, the American Society for Quality Control (ASQC), and the Association for Quality and Participation. The Malcolm Baldrige National Quality Award, established by law in 1987, was first awarded in 1988. The first year's winners were Motorola Inc., the Commercial Nuclear Fuel Division of Westinghouse Electric Corporation, and Globe Metallurgical Inc. Milliken & Company and Xerox Business Products and Systems won in 1989. Questions on general information and conference registration should be directed to ASQC at 414/272-8575.

1991 AWARD APPLICATIONS AVAILABLE

The application guidelines for the 1991 Malcolm Baldrige National Quality Award will be available in early December. The award promotes quality strategies. The booklet containing the application includes a description of the award, an application form, detailed instructions for completing the form, and specifics about the scoring criteria and examination. Free copies will be available from the Malcolm Baldrige National Quality Award Office, A537 Administration Building, NIST, Gaithersburg, Md. 20899, 301/975-2036.

QUALITY INVESTMENTS UP IN TWO KEY U.S. INDUSTRIES

Semiconductor and optical fiber firms in the United States have dramatically increased investments in quality practices over the past decade. Many are now funneling as much as a third of their operating budgets into total-organization approaches that aim to assure quality of both products and related services. This is a key conclusion of a report prepared for NIST. The study, covering the 1980-89 period, surveyed managers of prominent companies in the semiconductor and optical fiber industries. The study was commissioned to help NIST shape its own research programs, which assist and leverage measurement and quality aspects of industrial research and development. Copies of the report, U.S. Investment Strategies for Quality Assurance, are available free of charge. Send a self-addressed mailing label to Quality Report, c/o Dr. Gregory Tasse, A1002 Administration Bldg., NIST, Gaithersburg, MD 20899.

NIST WANTS INDUSTRY REACTION TO VIRUS CONSORTIUM

NIST is considering forming a government-industry consortium to combat computer viruses and related threats and would like to hear from others who are interested in the idea. "Computer system and software vendors want to devote their efforts to developing and marketing information technology, not fighting virus threats. Users need to have confidence in the reliability and safety of that technology," said a NIST computer security official on Oct. 2 at the 13th National Computer Security Conference. The consortium would enable NIST and the private sector to work together on a problem of common interest. Results of the consortium would be distributed as widely as possible. NIST has organized and managed several industry-government consortia and usually provides research facilities while the industry partners provide funding. Interested organizations should contact Dennis Steinauer, A216 Technology Building, NIST, Gaithersburg, MD 20899, 301/975-3359, or electronic mail: steinauer@ecf.ncsl.nist.gov.

NIST REGISTERS TEST SYSTEMS FOR GOSIP

NIST has assessed and registered a number of test systems as a first step in setting up a testing program needed to ensure that networking products purchased by federal agencies comply with the Government Open Systems Interconnection Profile—GOSIP (Federal Information Processing Standard 146). Federal agencies must use the GOSIP specifications in procuring networking products. The next step is to evaluate and accredit testing laboratories through the NIST National Voluntary Laboratory Accreditation Program. For a list of registered test systems or for further information about the GOSIP testing program, contact Jean-Philippe Favreau, 301/975-3634, or Stephen Nightingale, 301/975-3616.

"HOTLINE" TO REPORT ON EUROPEAN LAWS AND STANDARDS

Exporters, manufacturers, standards organizations, and others concerned about trade with the European Community (EC) may now telephone a recorded "hotline" message on draft EC laws and standards that might create technical trade barriers. The new hotline, which can be reached on 301/921-4164, is maintained by NIST and updated weekly. The hotline reports on proposed laws in

the form of directives and standards being developed by the EC and its two major standards development organizations in Brussels: the European Committee on Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC). Proposed standards also are reported from the European Telecommunications Standards Institute, which is working to unify the European telecommunications system. Hotline topics are listed by subject area and product. Information is provided on deadlines for comments, and a point of contact for obtaining a review copy of the text is given.

EUROPEAN REGIONAL STANDARDS ORGANIZATIONS LISTED

A new directory published by NIST is designed to help those concerned with the standards-related activities of regional organizations in the European Community and the European Free Trade Association. The Directory of European Regional Standards-Related Organizations (NIST SP 795), identifies more than 150 European regional organizations that engage in standards development, certification, laboratory accreditation, and other standards-related activities. Entries include addresses; telex, telephone, cable, and fax numbers; acronyms; national affiliations of members; membership restrictions; scope of interest; activities in standardization, certification, laboratory accreditation, and related fields; and the availability of standards in English. SP 795 is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC. 20402. Order by stock no. 003-003-03038-4 for \$10 prepaid. For a list of other standards-related and certification directories published by NIST, contact the Standards Code and Information Program, A629 Administration Building, NIST, Gaithersburg, MD 20899, 301/975-4031.

FIRST FELLOWS NAMED FOR STATISTICS PROGRAM

NIST and the American Statistical Association have named the first awardees of recently created senior research fellowships for applying statistical techniques to quality engineering. The subject areas to be addressed by the awardees include: accelerated reliability testing of products and more accurate coordinate measuring machine processes. Funded by grant from the National Science Foundation, the fellowships further collaborative research between engineers and statisticians on industrial quality and productivity needs, thus

bridging gaps between research and the use of statistical quality techniques.

FIRST LABS ACCREDITED FOR AIRBORNE ASBESTOS ANALYSIS

More than 115 laboratories have received the first accreditations to analyze airborne particulate asbestos under the National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos in schools. The asbestos testing program, administered by NIST, was established to meet the requirements of the Asbestos Hazard Emergency Response Act of 1986. Under the law, NIST is directed to evaluate and accredit laboratories that perform asbestos analysis of bulk insulation materials and of air samples taken from public schools after asbestos abatement procedures. A laboratory is accredited by NIST for 1 year and can maintain accreditation by continuing to demonstrate compliance with NVLAP criteria through on-site assessments every 2 years and twice-yearly proficiency testing. For information on the laboratories accredited for airborne asbestos analysis, contact David Alderman, Asbestos Program Manager, NVLAP, A124 Building 411, NIST, Gaithersburg, MD 20899, 301/975-4016. Information is also available by dialing the NVLAP computer bulletin board, available via modem at 301/948-2058.

NO EVIDENCE FOR FIFTH FORCE FOUND

The most sensitive gravity experiment of its kind ever conducted has failed to find evidence for a suggested "fifth force" in nature, according to researchers at the Joint Institute for Laboratory Astrophysics (JILA) in Boulder, CO. The results, which appeared in a recent issue of *Physical Review Letters*, rule out the existence of any such force at the magnitudes previously suggested. The experiment was carried out by a team of scientists working with a NIST scientist at JILA, a cooperative venture between the University of Colorado at Boulder and NIST. The experiment measured gravity at various heights on a 1,000-foot meteorological tower located 15 miles east of Boulder in Erie, CO. These measurements were then compared with the values that were predicted from surface gravity measurements and Newton's inverse-square law. The agreement found between the measured values and the Newtonian predicted values were excellent. The four known forces of nature are gravity, electromagnetism, the strong force that binds atomic nuclei, and the weak force that causes radioactive decay.

FIRST COMPARISON WITH SOVIET ATOMIC CLOCKS

NIST has facilitated the first-ever direct comparison between Soviet and American atomic time-keeping devices. In late September, two hydrogen masers developed by the Gorki R&D Instrument Making Institute were transported to the Smithsonian Astrophysical Observatory (SAO), Cambridge, MA. They are being compared with hydrogen masers at SAO for short-term performance. The clocks' long-term performance will be measured, via satellite hook-up, with NIST's atomic-clock ensemble in Boulder, CO. The Soviet institute has made major advances in hydrogen maser technology and has produced 150 of the devices for export and for use in a series of Soviet navigation satellites.

NIST, HIGHWAY INDUSTRY PROGRAM CELEBRATES 25 YEARS

Millions of dollars are spent every year to build and repair the nation's highways. Assuring that the materials used in this construction are of sufficient quality is the goal of a joint NIST/industry program. Since 1965, NIST and the American Association of State Highway and Transportation Officials (AASHTO) have sponsored the AASHTO Materials Reference Laboratory program at NIST to improve and standardize methods used to test highway construction materials such as asphalts, bituminous materials, and soils. As part of a voluntary program, AASHTO staff annually visit more than 80 testing laboratories to determine whether the methods and equipment used conform to national standards. In addition, they provide several thousand material samples to laboratories in the United States and abroad for comparative testing. In a similar program, NIST, through the Cement and Concrete Reference Laboratory, has worked with ASTM for more than 60 years to improve methods for testing other construction materials.

OPTICAL FIBER MANUFACTURERS ASK FOR NIST AID

The optical fiber industry has requested NIST to develop test methods needed for optical fiber geometry standards. Many feel traceable standards are needed if the optical fiber industry is to reduce tolerances on fiber cladding diameter. Narrower industry tolerances will allow connectors and splices with lower losses, which improves the performance of optical fiber systems. For details, write Aaron Sanders, Division 724.02, NIST, Boulder, CO 80303.

INFRARED WAVELENGTH MEASURING DEVICE DEVELOPED

A precision wavelength measuring device (lambdameter) for infrared radiation from diode and gas lasers has been developed at NIST. Intended as a working standard for wavelength measurement at 1.3 and 1.5 μm , the system also can be used in the red and near-infrared regions of the spectrum. The uncertainty of the lambdameter is about 2 parts in 10 million. Details of construction and testing are contained in Wavelength Measurement System for Optical Fiber Communications (NIST TN 1336). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC. 20402. Order by stock no. 003-003-03017-1 for \$2.50 prepaid.

WEIGHTS AND MEASURES HANDBOOKS REVISED

Two NIST handbooks have been revised to reflect changes adopted at the July 1990 annual meeting of the National Conference on Weights and Measures (NCWM). Established in 1905, NCWM is an organization of state, county, city weights and measures enforcement officials, and industry representatives. NIST, a nonregulatory agency, provides technical assistance to NCWM through its Office of Weights and Measures.

NIST Handbook 44-1991, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices. The major changes to Handbook 44 include a new table of marking requirements for scales, revised test procedures for coupled-in-motion railway track scales, a table of revised tolerances for scales without an accuracy class, and information on the Jan. 1, 1999, deadline to establish national uniformity of motor fuel dispensers used in multi-tier cash/credit pricing.

NIST Handbook 130-1991, Uniform Laws and Regulations. Besides modifications to the Uniform Weights and Measures Law, Packaging and Labeling Regulations, and Method of Sale of Commodities Regulation, a new section on NCWM policy, interpretations, and guidelines for defining products and services has been added to Handbook 130.

Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC. 20402. Order Handbook 44-1991 by stock no. 003-003-03052-0 for \$12 prepaid and Handbook 130-1991 by stock no. 003-003-03048-1 for \$10 prepaid.

IMPROVING CONTACTS TO HIGH- T_c SUPERCONDUCTORS

A broad-based method for making vastly improved electrical contacts to high-critical-temperature (high- T_c) superconductors is the subject of a new patent. NIST and industry scientists developed techniques for making ultra-low-resistivity contacts for various kinds of high- T_c ceramic oxide superconductors. Contact resistivity using these methods is less than a billionth of that of conventional indium-solder contacts. The work removes a serious obstacle to the commercial application of high-temperature superconductors in both large-scale and thin-film devices. The technology is available for licensing under U.S. patent number 4,963,523, "High- T_c Superconducting Unit Having Low Contact Surface Resistivity and Method of Making." Interested parties should contact Bruce Mattson, A343 Physics Building, NIST, Gaithersburg, MD 20899, 301/975-3084. Reprints of papers describing the techniques are available from Jack Ekin, Division 724.05, NIST, Boulder, CO 80303.

MAKING MEASUREMENTS ON HIGH- T_c SUPERCONDUCTORS

Measuring the critical current (I_c) of high-critical-temperature (high- T_c) superconductors has been more difficult than similar measurements on conventional low- T_c materials. Existing measurement practices and concepts bring inconsistency, ambiguity, and sometimes, invalid results. Measurements in high- T_c superconductors are sensitive to a number of subtle variables. If these variables are not thoroughly quantified and reported, the measurement may not be reproducible. A paper by NIST researchers, published in *Cryogenics*, describes pitfalls to be avoided and ways to minimize their effects. Suggestions regarding the measurement parameters and conditions to be included in reporting results are also given. Reprints (paper no. 48-90) are available from Jo Emery, Division 104, NIST, Boulder, CO 80303, 303/497-3237.

NEW SEPARATOR FOR BIOPRODUCTS

A NIST researcher has been awarded a patent for a simple, automated product separator—termed SEPSOL—for use in the supercritical fluid extraction of natural products from aqueous fermentation broths. The separator is expected to have direct application to the separation of beta-carotene—a basic source of vitamin A—from a water slurry. About 50 tons of beta-carotene are produced

annually with a market value between \$80 and \$100 million. It is used as a nutritional supplement, a food and drug colorant, a treatment for some skin disorders, and a possible anti-cancer agent. If successful in large-scale operations, SEPSOL should reduce the high cost of beta-carotene, which now averages \$35 a pound. For licensing information, contact Bruce Mattson, A343 Physics Building, NIST, Gaithersburg, MD 20899. For information on SEPSOL, contact Dr. Bruno, Division 584.03, NIST, Boulder, CO 80303, 303/497-5158.

DURING A FIRE, BRIGHTNESS IS BEST FOR EXIT SIGNS

Exit signs with stenciled, brightly lit red letters on an opaque background remain visible through smoke longer than other types of signs, NIST researchers found in a recent study. The researchers used both instrumentation and 21 observers to assess the brightness and visibility of 12 exit signs in both smoky and clear conditions. The signs varied in light sources, brightness, color, and lettering. Uniform lighting was another important factor in observers being able to detect and read a sign. In addition, unlike a Canadian study that suggested that green might be a more effective color for exit markings, the observers in the NIST study preferred red. However, the NIST researchers note, the red signs were brighter and the observers were accustomed to exit signs being red. A report, *Evaluation of Exit Signs in Clear and Smoke Conditions* (NISTIR 4399), is available from the National Technical Information Service, Springfield, VA 22161. Order by PB #90-269523 for \$17 prepaid.

PATENT COULD HELP ABATE ACID RAIN

Tighter controls on atmospheric pollutants expected with passage of the Clean Air Act Amendments of 1990 may revive interest in a NIST proposal for cleansing flue gases of noxious sulfur and nitrogen oxides. In 1982, NIST researchers logged patent 4,351,810 ("A Method for Removing Sulfur Dioxide from a Gas Stream"). The patent describes a novel chemical process that can remove SO_2 and NO_x (all implicated in acid rain problems) from exhaust gases without complicated equipment or critical temperature control. Moreover, the process could be designed to yield ammonium nitrates and sulfates, which are basic components of commercial fertilizers. In 1983, the invention received an "IR 100" award as one of the 100 most significant new technical products of the year.

POLYMER/SUPERCONDUCTOR COMPOSITES PATENTED

A patent was issued to NIST scientists for composites of certain polymers and high-temperature superconductors. The polymer composites may have applications in magnetic levitation and other uses of high-temperature superconductors for which electrical contact between superconducting grains is not essential. Advantages of these composites are ease of fabrication and enhanced toughness. The composites may be extruded into flexible fibers, ribbons, and sheets, or injection molded into complex shapes. Problems of brittleness and sensitivity to thermal cycling associated with ceramic superconductors are circumvented in the composites since mechanical properties are dominated by the polymer. When cooled to superconducting temperatures, the composites become stiff, but retain toughness. The patent was based on work at NIST on composites of a ceramic superconductor, (yttrium barium copper oxide) in a matrix of polyvinylidene fluoride. The polymer not only provides mechanical support and ease of fabrication, but also protects the superconductor from exposure to chemically active substances that can destroy the superconductivity.

MOLECULAR ORBITAL CALCULATIONS OF BOND RUPTURE IN BRITTLE SOLIDS

It is known that virtually all brittle solids ranging from completely ionic (MgF_2) to mixed ionic/covalent (SiO_2 , Al_2O_3) materials undergo environmentally enhanced bond rupture under monotonic loads, leading to flaw extension and ultimate failure. To further understanding of the bond rupture mechanism, molecular orbital calculations were carried out using an ab initio self consistent field technique. The work to date has involved investigations of the effects of strain on the atomic charges, bond overlap population, and ionic character of the Si-O bond at highly strained crack tips in silica (SiO_2). Silica was chosen as a model material because of the extensive experimental crack growth data available on it. Pyrosilicic acid, $\text{H}_6\text{Si}_2\text{O}_7$, was employed as the model molecule. Bond strains up to 30 percent were simulated in terms of bond stretching and angle distortion. The ultimate goal of this work is a method to predict material systems with an optimal resistance to environmentally enhanced fracture.

Results to date have shown that the net charge on the oxygen atom in silica becomes more negative as strain increases, while the net charge on the silicon atom varies depending on how the molecule

is distorted. These calculations are in general agreement with a previous model developed at NIST for chemically enhanced crack growth in oxides. According to this model, the chemical interaction between a strained bridging bond at the crack tip in silica and an adjacent water molecule involves the reaction of the oxygen lone pair electrons on the water molecule with a silicon atom and the transfer of a proton from water to the oxygen atom. The basic predictions of the model agree quite well with experimental crack growth data, not only in silica, but also in SiO_2 -based glasses as well as in single-crystal aluminum oxide.

WETTABILITY OF SOLDER ON INTERMETALLICS

Advanced microelectronic manufacturing depends on the ability of industry to produce reliable solder joints under automated conditions. However, in such joints, layers and dispersions of copper-tin intermetallic compounds often form. The wettability of these intermetallics by solder can be crucial in controlling solderability.

NIST scientists used rapid solidification and powder-processing techniques to prepare for the first time anywhere bulk samples of these intermetallics suitable for measuring wettability. Sessile drop measurements of wettability of lead-tin solder on these intermetallics were subsequently done at NIST. Results show that wetting behavior on the intermetallics is much poorer than that on copper but with proper fluxes may still produce the rapid solderability required by automated techniques. These results provide a quantitative basis for evaluation of soldering processes and mechanisms.

TWO NEW NIST PRECISION MEASUREMENT GRANTS AWARDED FOR FY 91

Two new \$30,000 NIST precision measurement grants have been awarded for fiscal year 1991. The recipients, John E. Thomas of Duke University and Ngai C. Wong of the Massachusetts Institute of Technology, were selected from an initial group of 37 candidates. NIST sponsors these grants to promote fundamental research in measurement science in U.S. universities and to foster contacts between NIST scientists and researchers in the academic community actively engaged in such work.

Thomas' project "Precision Atomic Position Measurement Using Optical Fields," will develop new optical techniques for achieving ultrahigh spatial resolution of moving atoms. The goal is to

achieve nanometer resolution limited by the uncertainty principle for highly collimated or transversely cooled atomic beams.

Wong's project, "Optical Frequency Division Using an Optical Parametric Oscillator: Applications to Precision Measurements," will develop a new method of frequency division based on optical parametric downconversion in a nonlinear crystal. The method will convert the signal from an unknown input laser into two coherent subharmonic outputs with linewidths limited by the input pump linewidth. By locking their difference frequency to a known reference source, the output frequencies and hence the frequency of the unknown may be determined precisely.

NEW LASER TELEMETERING DOSIMETRY SYSTEM DEVELOPED

A long-range laser-based system for the remote detection and dose quantitation of gamma-ray and x-ray radiation fields has been developed at NIST. The system will allow on-line measurements in high-dose environments such as nuclear power plants and radiation processing facilities. It employs GafChromic™ dosimetry media, a radiosensitive film that upon exposure to ionizing radiation, visibly darkens as a function of dose, and a helium-neon laser operating at the wavelength of 632.8 nm. The film is "read" by measuring the transmitted light intensity of an incident beam and converting that quantity to an optical density, thus yielding an optical density versus dose relationship. With the present film, the applicable dose range is 1 to 1000 gray. (One gray (Gy) is equal to 1 J/kg.) The basic system can be configured for real-time, on-line monitoring of radiation procedures in industrial radiation processing as well as other industrial and military applications.

FAST INFORMATION RETRIEVAL SYSTEM

NIST scientists developed a computer system that automatically retrieves relevant text from large databases in response to simple natural language user queries. The information retrieval system accepts a simple user query such as a sentence or a phrase and returns a list of records ranked in order of likely relevance to that query within 1 or 2 s. The computer system is particularly well suited for retrieval from manuals, sets of related records, bibliographic files, and other types of data containing sufficient amounts of text.

NIST PUBLISHES GUIDELINES TO EVALUATE MESSAGE HANDLING SYSTEMS (MHS)

NIST Special Publication 500-182, Guidelines for the Evaluation of Message Handling Systems Implementations, assists users in determining which implementation, among several candidates, will best meet the functional and performance requirements of the user. The document provides guidance for evaluating the functional specifications of MHS implementations, for measuring the performance of MHS implementations, and for matching the functional and performance specifications of an MHS implementation to user requirements. FIPS 146, GOSIP, Version 1, mandates that federal agencies procure MHS products to provide the electronic mail capabilities required by those agencies as of August 15, 1990.

NIST HOSTS EMC/EMI MEASUREMENTS SHORT COURSE

NIST recently hosted a short course on measurements for determining electromagnetic compatibility/electromagnetic interference (EMC/EMI), principally based on methods developed by the NIST fields and interference metrology group.

The course was offered in response to requests from NIST clientele and others in having the opportunity for intensive exposure to NIST developments in this area of growing national concern.

Some 40 participants from industry, other government agencies, and academic institutions learned about NIST measurement services; measurements in support of FCC regulations and military standards; and measurement methods and instrumentation, including electromagnetic probe development, the use of transverse electromagnetic cells and reverberation chambers, whole-system testing, and the determination of shielding effectiveness and site attenuation. The course also provided the NIST organizers with information on practical measurement needs faced by industry.

X-RAY DIFFRACTION PHASES DETERMINED FROM NATIVE PROTEIN DATA

Scientists at NIST and a Swedish University have developed a method for applying the principle of maximum entropy to the problem of determining the phases of x-ray diffraction data from biological macromolecules such as proteins. Previously used methods for determining phases, which are necessary for determining the structure from the diffraction data, have depended on the ability to

incorporate heavy atoms into crystals of proteins or on prior knowledge of the structure of some major fraction of the molecule. The new method can be used with data obtained from the native protein alone and with no prior knowledge except for approximate chemical composition.

Employing 1970 reflections, the method has been used to produce an electron density map of the known structure of recombinant bovine chymosin that is in remarkable agreement with one calculated using phases determined from the refined structure (12346 reflections). This method for determining phases *ab initio* from native protein data alone opens the way to a major advance in the ability to determine the structures of the macromolecules that play vital roles in all life processes.

THE INFLUENCE OF LITHIUM ON THE CORROSION BEHAVIOR OF ALUMINUM ALLOYS

Lithium is an important alloying element in aluminum because it reduces density while simultaneously increasing strength and stiffness. Aluminum-lithium alloys and metal matrix composites made with these alloys promise to improve the performance and efficiency of aircraft and other vehicles. However, the addition of an alloying element as active as lithium may dramatically alter the corrosion behavior of aluminum alloys. Numerous investigations have been conducted into the corrosion behavior of aluminum-lithium alloys but these studies have failed to distinguish between the effect of the precipitation of lithium rich phases from the influence, if any, of lithium on the growth and stability of passivating films on the surface of aluminum alloys. To resolve this issue, the NIST corrosion group developed a new experimental technique for the evaluation of electrochemical reactions on the bare surface of aluminum alloys. This technique was used to examine the rate of dissolution and passive film growth on the bare surface of aluminum-lithium binary alloys with differing lithium contents. It was found that lithium does not alter the dissolution rate or the repassivation rate of these alloys unless they are heat treated in such a manner as to yield large lithium rich precipitate phases at the grain boundaries. That is, aluminum-lithium alloys do not inherently have a poor corrosion resistance and, if heat treatment procedures are developed that suppress the nucleation and growth of the lithium rich precipitate phases at the grain boundaries, then the corrosion resistance of these alloys will be essentially identical to that of other aluminum alloys.

DEVELOPMENT OF A NIST X-RAY MICROFLUORESCENCE SPECTROMETER

An x-ray spectrometer has been constructed at NIST for performing multielement compositional analysis of areas on samples as small as 50 μm . This new technique, called x-ray microfluorescence spectrometry, represents a new capability for materials characterization and has been developed as part of an industrial cooperative research project. This system allows automated, programmable X-Y scans of samples with simultaneous x-ray data acquisition and spectral deconvolution functions. In a demonstration of capabilities, x-ray fluorescence analysis of areas 200 times smaller than those used for bulk analysis of stainless steels gave elemental compositions that agreed with the bulk values within 2-3 percent. The instrument also will be useful in assessing the properties of films, including the homogeneity of chemical composition of small regions compared to the bulk chemical composition, film thickness, and potentially on-line process control.

NIST PROVIDES STANDARDS SUPPORT FOR NASA SATELLITE PROGRAM

A NIST scientist is playing the lead role in standards activities for two important NASA programs during his assignment at NASA's Langley Research Center for 1 year under a special interagency agreement. One of these is the SAFIRE (spectroscopy of the atmosphere using far-infrared emission) experiment, which will use satellite measurements to furnish a global measurement of the critically important OH radical. The second is IBEX (infrared balloon experiment), which involves balloon-based measurements of the ozone chemistry of the upper atmosphere to be followed by correlative measurement flights in support of the upper atmosphere research satellite. He has been working with other NIST staff to make sure that the measurement systems being developed for these NASA programs are traceable to national standards and of sufficient quality to support the missions of the programs.

NIST COSPONSORS INTERNATIONAL CONFERENCE ON OPEN SYSTEMS STANDARDS

Calling for "common solutions that serve both users and vendors who want to compete in an international marketplace," Under Secretary Robert White keynoted the 6th International Conference on the Application of Standards for Open Systems. White challenged the international community to

work together to develop policies, standards, and conformance tests that will advance the development and use of open systems. More than 150 computer professionals from government, industry, and user organizations worldwide attended the October 2-4, 1990, conference, which was cosponsored by NIST, the Institute of Electrical and Electronic Engineers (IEEE), and the IEEE Computer Society. The conference program featured 36 experts representing governments throughout the world who addressed the key issues affecting the implementation of open systems: policy development, international collaboration, free trade and standards, Open Systems Interconnection applications, conformance and interoperability, and security.

COMPUTER SECURITY GUIDANCE PUBLISHED

Four new publications report on computer security studies and guidelines developed by other federal agencies. U.S. Department of Energy (DOE) Risk Assessment Methodology (NISTIR 4325) presents risk assessment guideline instructions, a resource table, and a completed sample as well as DOE risk assessment worksheets. Domestic Disaster Recovery Plan for PCs, OIS, and Small VS Systems (NISTIR 4359) describes a disaster recovery methodology. Automated Information System Security Accreditation Guidelines (NISTIR 4378) provides procedures developed by the Federal Aviation Administration for the preparation of documentation for the security accreditation of automated information systems. U.S. Department of Justice Simplified Risk Analysis Guidelines (NISTIR 4387) contains a risk analysis methodology. NIST published these documents as part of a continuing effort to assist federal agencies in improving the security of their information systems and to make useful information available to the federal community.

NIST HOSTS SLATEC MEETING ON LIBRARY SOFTWARE

NIST hosted the fall meeting of the SLATEC committee, the group that develops and maintains mathematical software for scientific computing applications at member government and national laboratories.

The SLATEC committee produces a comprehensive library that features uniform documentation and error handling, quality control through

careful testing requirements, effective utilization of vector supercomputers, and portability to almost any computer with a Fortran compiler. The scope of the SLATEC library is comparable to that of the commercial IMSL and NAG libraries.

A major new software program, representing a capability not found in IMSL and NAG, was accepted into the library at the fall meeting. This software includes a set of routines for computing Wigner 3j and 6j coefficients, also known as Clebsch-Gordan coefficients, used in quantum mechanics and the theory of angular momentum. The routines were produced jointly by Harvard University and the Max Planck Institute. As required by the SLATEC library, the Wigner software passed an independent validation test developed by NIST.

NIST INITIATES RESEARCH FOR HALON REPLACEMENTS

NIST Scientists have completed the first two projects in a government-industry plan to identify and qualify replacements for the halogenated fire suppressants (halons). These chemicals have been designated for phase-out due to their destruction of stratospheric ozone. The projects incorporate state-of-the-art in testing methodology and mechanistic thinking. The two reports, entitled Preliminary Screening Procedures and Criteria for Replacements for Halons 1211 and 1301 and Construction of an Exploratory List of Chemicals To Initiate the Search for Halon Alternatives, have been issued as NIST Tech Notes 1278 and 1279, respectively.

NIST DEMONSTRATES SMOKE TOXICITY DATA RELEVANCE

For the first time, NIST scientists have shown a relationship between the toxicity of room fire smoke and that measured in the combustion of small samples. Two bench-scale apparatus and protocols, one developed at NIST and the other developed jointly with an outside organization, produce data that agree with data from newly conducted wall fire experiments on multiple bases such as: toxic potency of the smoke, sameness of toxic species, similar yields of toxic species, and agreement of toxic potency prediction. The agreement is accurate to within a factor of 3, which is within acceptable limits for the prediction of life safety in building fires.

DIRECT FORGING OF STEEL

NIST is collaborating with industry to study microalloyed bar steels for direct forging application. The direct forging process is of interest to the automotive industry because the properties of forged parts meet specified levels without the need for subsequent heat treatment. The idea is to control the temperature-deformation schedule during forging and cooling in order to achieve the desired metallurgical structure and properties.

Metallurgical data on microalloyed SAE 1141 and AISI 1522 steels were provided by industry. High-temperature, high-strain rate flow curves and continuous cooling transformation diagrams under different temperature-deformation schedules have been measured for these two steels. The information provides the basis for optimizing the forging schedule. Theoretical models are being used to make the high-temperature deformation behavior and the transformation kinetics applicable to a wide range of forging conditions.

SOCIETY OF AUTOMOTIVE ENGINEERS AND NIST USE NEUTRON DIFFRACTION TO CHARACTERIZE RESIDUAL STRESSES

NIST scientists are collaborating with engineers of the Fatigue Design and Evaluation Committee of the Society of Automotive Engineers in a multiaxial fatigue lifetime prediction project. The project is part of an integrated engineering approach for design analysis and validation of components for vehicles. Specifically, component-like axles will be tested for fatigue life; characterized for materials properties, including residual stress; and modeled by finite-element techniques. Neutron diffraction has particular value in this application because it is nondestructive and because the penetrating power of neutrons allows probing of residual stresses virtually to the center of the 40-mm diameter axles.

To date, two axles have been examined: one which was induction hardened but not fatigued; a second was hardened and fatigue cycled to about half of the expected lifetime. Even in the unfatigued sample, significant differences from the initial, calculated stress distribution were seen. The fatigued specimen shows a clear asymmetric redistribution of stresses not yet predicted by finite element methods.

PATENT SOUGHT FOR ASSAY FOR ATAXIA TELANGIECTASIA

In collaboration with the Imperial Cancer Research Fund, researchers at NIST have developed an assay that has the potential of detecting the disease ataxia telangiectasia (AT) before the onset of symptoms. AT is a human genetic disease characterized by an extreme sensitivity of the body's cells to the lethal effects of ionizing radiations (γ rays, x rays, etc.). The disease is first manifested in early childhood (2 years) when changes similar to accelerated aging, malignancies, and immune dysfunction appear. Death usually occurs by age 25, and currently there is no cure. Early detection is expected to lead to more effective treatments, especially in the inhibition of malignancies and boosting of the immune system.

During studies of the biochemistry of the enzyme deoxyribophosphodiesterase (dRpase) in various cell lines, NIST researchers detected a modified deoxyribosephosphate (dRp-X) in the assay for an AT patient. The modified enzymes behaved the same as normal enzymes, but appeared only in cell lines derived from AT patients (seven, so far). It is not detectable in any other diseased or normal cell lines. This product has been identified tentatively by gas chromatography/mass spectrometry, and a patent for its use as a marker for AT has been filed in Europe and the United States.

NIST DEVELOPS STANDARD OF RHENIUM-186 FOR RADIOPHARMACEUTICAL MANUFACTURERS

At the request of radiopharmaceutical manufacturers and medical investigators, NIST has developed new radionuclide standards of ^{186}Re . Rhenium-186 is a short half-life radionuclide now undergoing investigation in a number of clinical trials for improved cancer treatment. Industry is providing a ^{186}Re bone-seeking pharmaceutical for clinical trials at the University of Cincinnati, University of Utrecht (Netherlands), and Memorial Sloan-Kettering. This material is intended to reduce pain from bone metastases for terminal patients. Industry is developing ^{186}Re -labeled monoclonal antibodies which are being used in clinical trials at the Virginia Mason Medical Center, Memorial Sloan-Kettering, and other centers. These tumor-specific radiolabeled antibodies are targeted to kill colon, ovarian, and small-cell lung cancer cells.

Two batches of the radionuclide were obtained from the University of Missouri Research Reactor, and the half-life was measured at NIST as

89.25 \pm 0.07 h. The radionuclide was standardized by liquid-scintillation counting, and measurements were made on the photon emission rates of the principal x and gamma rays using semiconductor detectors. The uncertainty in the standard is \pm 1.6 percent, which will allow physicians to assay radiopharmaceutical injections to within \pm 5 percent.

HIGH-RESOLUTION PROTEIN SEPARATIONS APPLIED TO CANCER RESEARCH

NIST scientists in collaboration with researchers from four prominent cancer research institutions have developed a procedure, based on two-dimensional electrophoresis (2-DE) with computer-assisted image analysis, capable of detecting molecular changes that occur in cancerous vs. normal cells.

The 2-DE separations and imaging procedures developed at NIST allow visualization of picogram quantities of individual proteins. Experimental measurements have been made using human colon cancer cell lines and malignant gastric and colon tumorous tissues. The NIST-developed technology, based on the appearance or disappearance of 10 to 20 selected proteins from complex maps containing more than 2,000 proteins, appears to be capable of detecting the onset and progress of various types of carcinoma.

This technology shows immediate potential for use in cancer diagnosis and treatment. Proteins related to cancer development can be isolated and sequenced. The sequence then can be decoded to determine which genes are being expressed. This technology also has potential as a molecular basis for selecting chemopreventive agents.

NIST ESTABLISHES RESEARCH PROGRAM TO SUPPORT THE ADVANCEMENT OF DNA PROFILING TECHNOLOGY

In collaboration with the National Institute of Justice, NIST scientists and other researchers have established a program to address standards and rapid-high-resolution separation needs in forensic DNA profiling. A guest scientist is focusing his efforts on the development of a moving boundary electrophoresis system that uses a novel medium for separations. A visiting forensic serologist is using FBI protocols for DNA fingerprinting to qualify cell lines and molecular weight standards for use as reference materials. One output of the program is the discovery of techniques for modification of electrophoresis media that allow various DNA-size fragments to be separated in less than

1 h, as compared to 15 or more hours using current procedures. A patent disclosure has been submitted based on this effort.

The DNA separations and standards research at NIST is being followed with great interest by the worldwide forensic community, since standardization and quality assurance of DNA fingerprinting methods have become important considerations in many criminal court cases. Interlaboratory studies to assess the DNA profiling capabilities of forensic labs will be conducted later this year employing materials qualified and value assigned at NIST. This exercise will serve as a prelude to the development and issuance of SRMs to support DNA fingerprinting technology.

PARALLEL PROCESSING RESEARCH REPORTED

Workloads, Observables, Benchmarks and Instrumentation (NISTIR 90-4275) describes research on measuring the performance of computer systems. Partially supported by two other government agencies the research focused on a compact user-level summary that captures the performance variabilities of a system. NIST researchers used a dependency tree to delineate the relationships among a very limited number of major system resources that explain most performance variance. The tree supports simple predictions and promotes more meaningful comparisons of workloads.

ENHANCED CRITICAL CURRENT ACHIEVED THROUGH GRAIN ALIGNMENT OF BULK HIGH-CRITICAL-TEMPERATURE SUPERCONDUCTORS

A NIST scientist in collaboration with industry researchers, has demonstrated an enhancement of transport critical current (J_c) as a result of deliberate grain alignment in bulk polycrystalline yttrium-barium-copper oxide superconductors. Their research provides clear evidence that it is possible to achieve relatively high supercurrents across grain boundaries at high magnetic fields (up to 30 T at 77 K). The work also shows the existence of a "good" component of current conduction across grain boundaries and that the amount of good material can be manipulated. The limited current-carrying capacity of the ceramic superconductors in relatively high-magnetic fields poses a serious limitation to their practical exploitation. The results of these tests show the importance of grain alignment in achieving higher current capacity.

Calibration Services

NEW TRANSIENT HIGH-CURRENT CALIBRATION CAPABILITY ESTABLISHED

NIST has developed capability and an associated special-test measurement service for calibrating and evaluating high-current sensors, initially in response to needs of the resistance welding industry. Currents as high as 100 kA can be generated and measured with an uncertainty of less than 0.35 percent. Support of present welders requires a capability of about 50 kA, although a new generation of welders is being developed which may require capability even above 100 kA. The welding industry needs more accurate measurement of power-line frequency welding burst currents than heretofore available, in order to achieve better weld quality in critical applications such as oil and gas pipelines and nuclear reactor power plant plumbing. Typical sensors used in the measurements are four-terminal shunts (having a resistance of 20 $\mu\Omega$ or less), or Rogowski coils (air-core mutual inductors having a mutual inductance of 1 μH or less). Because of the transient nature of the measurements, high-speed digitizers are used to capture the signals, and digital processing is carried out immediately after a measurement run. Prior to the development of the new capability, the highest current that could be generated by NIST for similar measurement purposes was only about 6 kA. As a derivative effort from the welding work, methods and apparatus are being developed to characterize equipment used in the testing of circuit breakers. This application requires a NIST current capability of about 80 kA.

Standard Reference Materials

NEW GLASS DENSITY STANDARDS AVAILABLE FOR INDUSTRY

NIST has developed four new standard reference materials (SRMs) for the producers of flat and container glass products. The SRMs are quality control standards for calibrating densitometers and other instruments used to measure the density of solids and liquid materials. Each of the SRMs has a certified density value determined by hydrostatic weighing. SRM 1825, Fused Silica Density Standard; SRM 1826, Soda-Lime Glass Density Standard; and SRM 1827, Lead Silica Glass Density Standard are available for \$133 each. SRM 1919, Lead Silica Glass Density Standard, is the same

material as SRM 1827 but each unit is individually certified to the sixth decimal place. It is priced at \$168. The new glass density standards are available from the Standard Reference Materials Program, Room 204, Building 202, NIST, Gaithersburg, MD 20899, 301/975-6776, fax: 301/948-3730.

COMPUTER MAGNETIC TAPE CERTIFIED AS A STANDARD REFERENCE MATERIAL

SRM 3201 is a computer magnetic tape calibrated and certified as a standard reference material for the 1/2-in serial serpentine 22-track and 48-track tape used by many minicomputers. The SRM is specified by American National Standard X3.181 for the recorded tape and by a forthcoming standard for the unrecorded tape. The magnetic properties specified are output signal amplitude, typical field, overwrite, resolution, and peak shift. These properties are specified at two densities: 6667 ftpi (flux transitions per inch) and 10,000 ftpi.

SRM 3201 is needed by manufacturers of the tape media and the tape drives to assure conformance with ANSI X3.197 and X3.181. Industry support of the research came from six companies. Five other SRMs developed by NIST for different types of computer magnetic tape are available from the Office of Standard Reference Materials.

Standard Reference Data

PC DATABASE TO SPEED USE OF ADVANCED CERAMICS

A new structural ceramics database (SCD) for personal computers (PCs) is designed to speed the application of high-temperature advanced ceramic materials from the laboratory to the marketplace. The database was developed by NIST materials scientists, with industry support. SCD provides design engineers with rapid access to important information on the thermal and mechanical properties of silicon carbide and silicon nitride monolithic materials. These materials are primary candidates for the manufacture of heat exchangers, ceramic engine components, sensors, and cutting tools because of their high strength and dimensional stability, chemical inertness, and wear resistance. NIST Structural Ceramics Database (SCD), Standard Reference Database 30, is available for \$495. To order PC Version 1.0, contact the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899, 301/975-2208, fax: 301/975-2183.